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TECHNICAL REVIEW OF FLUORESCENT PENETRANT PROCESS DELTA AIRLINES, INC.

AUGUST 13 & 14, 1996

(FAA DOCUMENT)

(45 PAGES)

TECHNICAL REVIEW OF

FLUORESCENT PENETRANT INSPECTION PROCESS

DELTA AIR LINES, INC.

AUGUST 13 & 14,1996

CONDUCTED BY** THE **FEDERAL AVIATION ADMINISTRATION

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Questions concerning distribution of this report should be addressed **to:** Manager, Engine and Propeller Directorate.

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I. EXECUTIVE SUMMARY

The Manager, Engine & Propeller Directorate, formed a Fluorescent Penetrant Inspection (FPI) Process Technical Review Team on August 6, 1996, to review the FPI processes and operations at Delta Air Lines, Inc. This Team conducted their review on August 13 and 14, 1996, at Delta Air Lines, Inc., Atlanta, The team identified three major areas that may explain the nondetection of a critical crack in Pratt & Whitney JT8D-219 No. 1 engine front compressor front hub (fan hub).

The three major areas identified by the Team are as follows: Qualification of Personnel, Cleaning, and the FPI process. The bulk of this report is devoted to summarizing the Observations and Recommendations to improve the detectability of cracks using FPI. Additional observations were made in other areas and are also included in this report.

Also included in this report are comments received from Delta Air Lines, Inc., addressing the Observations and Recommendations of this report. Both during and following the Team's visit, Delta Air Lines, Inc., has initiated positive and responsive actions to the Team's recommendations.

II. TEAM MEMBERS

TEAM LEADER.

ALFRED BROZ
NRS-Nondestructive Evaluation
Aircraft Certification Service

TEAM MEMBERS:

JOHN HARRINGTON
Aviation Safety Inspector
Aircraft Evaluation Group
Flight Standards Division

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Aerospace Engineer
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Aviation Safety Inspector
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III. BACKGROUND SUMMARY

On July 6, 1996, Delta Air Lines, Inc., Flight No. 1288, a McDonnell-Douglas MD-88 aircraft, experienced an uncontained failure of the No. 1 engine front compressor front hub (fan hub) during takeoff at the Pensacola Regional Airport, Pensacola, Florida. The aircraft was equipped with Pratt & Whitney (PW) JT8D-219 engines.

An investigation revealed that during the takeoff the fan hub separated into two sections approximately 120 and 240 degrees of the circumference with fan and/or engine debris penetrating the aft cabin area, resulting in two fatalities and one serious injury. The fractured fan hub, Part Number 5000501-01, Serial Number R32971, was last inspected using the FPI process at Delta Air Lines, Inc., after accumulating 12,693 flight cycles in December 1995. The fan hub failed at 13,835 cycles (1,142 cycles since last inspection). The published life limit of this fan hub is currently 20,000 cycles. Maintenance records indicate that all scheduled maintenance on the fan hub was performed by Delta Air Lines, Inc.

The investigation also revealed that the fan hub failure resulted from a fatigue crack that originated in a tie bolt hole. The fatigue crack initiated from mechanical surface damage produced during the machining of the tie bolt holes at manufacture, and propagated in a low cycle fatigue mode due to normal engine start-stop cycles. The manufacturing records indicated that a surface anomaly was observed in a tie bolt hole during the Blue Etch Anodize Inspection. The anomaly was dispositioned to be acceptable at that time.

The National Transportation Safety Board (NTSB) performed a metallurgical examination that suggests a 1.36 inch crack in total surface length was present at the last FPI process. The crack extended 0.46 inches on the aft end face of the hub and continued along the wall of a tie bolt hole approximately 0.9 inches. Published reliability data from the Nondestructive Testing Information Analysis Center indicates that a crack of this sue should be detectable with a probability of detection and confidence level both exceeding 95 percent.

In an effort to determine the inconsistencies between published reliability data and the results achieved by Delta Air Lines, Inc., the Manager, Engine & Propeller Directorate, formed a FPI Process Technical Review Team on August 6, 1996, to review the FPI processes and operations at Delta Air Lines, Inc. This Team conducted their review on August 13 and 14, 1996, at Delta Air Lines, Inc., Atlanta, Georgia. This Team provided In-Briefings and Out-Briefings to both Delta Air Lines, Inc., and the Delta Certificate Management Office, Atlanta, as part of the Technical Review.

IV. OBSERVATIONS AND RECOMMENDATIONS

A. Qualification of Personnel

Section **13.A** of Delta Air Lines, Inc., Nondestructive Inspection Training Procedure NDT-1, Revision 10, dated May 1, 1996, requires "All levels of personnel shall attend annual recurrent training in each method of certification no later than **30** days after the anniversary date of the previous recurrent or initial training".

Observation **No. 01 : A** review of records in Department No. **542,** indicates that recurrent trainings were performed beyond the 30 day grace period.

Recommendation: The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta **Air** Lines, Inc., is in compliance with the Nondestructive Inspection Training Procedure NDT-I, Revision 10, dated May 1, 1996, regarding recurrent training.

Section **14.A** of Delta **Air** Lines, Inc., Nondestructive Inspection Training Procedure **NDT-1,** Revision 10, dated May 1, 1996, requires ***"An*** individual remains qualified by performing work, providing instructions to trainees, and demonstrating proficiency in a method. Failure to do so within **six** months shall require the individual to be re-qualied by recurrent training."

Observation **No. 02:** Delta Air Lines, Inc., does not have an acceptable procedure to administer **this** requirement. The Team noted that it **was** up to each individual's Foreman to notify the Engine Maintenance Quality Assurance Manager of inactivity.

Recommendation: The Team recommends that an acceptable procedure be instituted by Delta Air Lines, Inc., to ensure that the individuals exceeding six months of inactivity do not perform inspections until they have been re-qualied, and that the Delta Certificate Management Office, Atlanta, review the procedure for acceptability.

Section 15.A of Delta Air Lines, Inc., Nondestructive Inspection Training Procedure NDT-I, Revision 10, dated May 1, 1996, requires "All levels of personnel shall be re-certified at least every three years. This re-certification shall be based upon (a) evidence of continuing satisfactory performance; or (b) re-qualification by examination".

Observation No. 03: The Team noted that re-qualification is based primarily on continuing satisfactory performance in lieu of an examination.

Recommendation: The Team recommends that the current practices of Delta Air Lines, Inc., be revised to require re-qualification of an individual by taking a written and a proficiency examination. The Team recommends that the Delta Certificate Management Office, Atlanta, review these revised practices for acceptability.

Delta Air Lines, Inc., Operations Policies and Procedures, 00-10-25, dated June 12, 1996, defines duties of a Powerplant Processor. Currently Delta Air Lines, Inc., utilizes Processors for the FF'I process.

Observation No. 04: During the Team's review, it was noted that there is no "formal" procedure to document the qualification of Processors. The Team also noted that unlike the Inspector, the Processor does not have "formal" On the Job Training (OJT).

Recommendation: The FPI is highly process dependent, and therefore, the Team recommends that Delta Air Lines, Inc., reconsider the use of Processors for the FPI. The Team also recommends that Delta Air Lines, Inc., establish a "formal" procedure to ensure that Processors are qualified to perform their role in FPI. The Team recommends that one way this may be accomplished is to manage Processor qualification in a way similar to that used for Inspectors. The Processor Qualification Procedure at Delta Air Lines, Inc., should be reviewed for acceptability by the Delta Certificate Management Office, Atlanta.

Observation No. 05: Delta Air Lines, Inc., cleaning personnel receive OJT, with no formal classroom training. On the Job Training is provided on each special cleaning operation and is logged in records established within the engine cleaning department. The Team noted that sensitivity to the criticality of the engine components and the end purpose for which these components were being cleaned after being inducted into the cleaning shop was not provided as part of the OJT (critical rotating vs. static, general visual inspection vs. Nondestructive Inspection).

e Delta Air Lines, Inc., engine cleaning g personnel ıld
t p ıf in the OJT program g t the differences in types of material
and the a nature of cleaning pc t which will t be released from tl cleaning shop
for FP . The revised OJT program at D Air Lines Inc , for cleaning personnel, should be
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B. Cleaning

On August **13-14,** 1996, a review of Delta **Air** Lines, Inc., Powerplant Engine Cleaning Department was conducted as part of the Team review. The Delta **Air** Lines, Inc., Engine Cleaning Department is considered by the Team as an integral part of the FPI process.

Observation No. 1C: There were noted discrepancies between audits performed by **TURCO,** a provider of cleaning chemicals, and Delta **Air** Lines, Inc., concerning cleaning tank solution contents. The corrective actions taken to bring the cleaning solution tanks within specification, by adding chemicals, were significant. No attempt was made by the Team to verify which **was** the correct audit.

Recommendation: The Team recommends that Delta **Air** Lines, Inc., establish weekly comparison inspections/audits within the engine cleaning department to review both TURCO and Delta **Air** Lines, Inc., audit reports of cleaning tank chemical composition. When disparities between reports are noted they should be rectified before further processing. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of the Delta **Air** Lines, Inc., management of cleaning tank chemical composition.

Observation No. 2C: Interviews with Delta Air Lines, Inc., management and shop personnel indicate that Delta ***Air*** Lines, Inc., has a written procedure for cleaning processes for engine components. These written processes are developed by Delta **Air** Lines, Inc., Process Engineering, either from the Original Equipment Manufacturer (OEM) Instructions for Continued Airworthiness, Chemical Product Distributors or Delta **Air** Lines, Inc., Process Engineering. **A** full comparison of OEM data to Delta **Air** Lines, Inc., interpretative instructions was not conducted as part of this review. Delta **Air** Lines, Inc., process instructions for the cleaning of engine components are dictated by the shop source of the component being inducted for cleaning

on Job **Planning** Cards (JPC's). The components inducted into the engine cleaning shop are accompanied by this Delta Air Lines, Inc., JPC which lists the cleaning process to be applied to the component. Specific cleaning process steps for those JPC's are contained in a manual, which is generally located in the cleaning shop foreman's office and are available to shop personnel. That manual will be referred to as the cleaning shop manual.

Specific process steps to clean engine components are not located at the cleaning worksites for cleaning personnel to review before commencing cleaning operations. Cleaning operations appear to be committed to memory for the components being cleaned, which could lead to errors in the cleaning process due to human factors.

Recommendation: The Team recommends that Delta **Air** Lines, Inc., develop engine cleaning instructions, or job aid instructions, such as material types, chemical solutions to be used, temperatures and dwell times. These process instructions should also accompany the component through the cleaning process and be readily available at the work sites so that cleaning personnel will not have to rely on memory recall for cleaning processes. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of the instructions.

Observation **No. C3 :** The Team observed that changes to cleaning processes, when necessary, are developed by Delta *Air* Lines, Inc., Process Engineering and routed to the cleaning shop for inclusion into the cleaning shop manual. The cleaning personnel are advised of these changes to the cleaning processes by the shop foreman or lead cleaners. It is not clear that should cleaning process operations change, with the absence of the foreman or lead cleaner, those changes would be distributed to cleaning personnel

Recommendation: The Team recommends that a more formal process **be** established by Delta Air Lines, Inc., so that all cleaning personnel are consistently aware of changes made in the cleaning processes. The Team recommends that the Delta Certificate Management Office, Atlanta verify the acceptability of the process.

Observation **No. C4:** There is no apparent procedures to verify with Delta Air Lines, Inc., Process Engineering that cleaning process changes have been implemented in the shop department.

Recommendation: The Team recommends that a consistent method be established to ensure that cleaning process changes are properly implemented and documented with Delta Air Lines, Inc., Process Engineering. The Team recommends that the Delta Certificate Management Office. Atlanta verify the acceptability of the method.

Section 4.C(1)(a)(1) of Delta Air Lines, Inc., Process Standard 900-1-1 No. 18, dated February 1, 1996, Requires that "Maintain tank solution at normal operating level with TURCO 5948R ...at 145°F to 155°F".

Observation No. C5: The Team noted that tank solutions are checked on a weekly basis to ensure that proper temperatures are maintained. This weekly check is recorded on a log sheet which records the temperatures for the TURCO 5948R and TURCO 4181 tanks. The acceptable temperature range noted on this log sheet (tank #1 cold line (CL)) is 140°F to 180°F, which is not in accordance with the temperature range identified in the noted Process Standard. A review of this log sheet indicates that the solution temperature has been out of limits for approximately one month. In addition, the TURCO 4181 solution temperature (tank #3 CL) has been out of limits for approximately one month as well.

Recommendation: The Team recommends that the tank temperatures be maintained in accordance with the noted Process Standard, and that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., is in compliance with this standard. Additionally, the Team recommends that Delta Air Lines., Inc., ensure that the cleaning equipment temperatures are in range, as indicated on temperature meters at the cleaning tanks, prior to processing components on a daily basis.

Section 4.D.(1)(c) of the Delta Air Lines, Inc., Process Standard 900-1-1 No. 18, dated February 1, 1996, requires a hot water rinse following the TURCO 5948R step.

Observation No. C6: This step was not performed during the cleaning process.

Recommendation: The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., is in compliance with this Process Standard.

Section 4.F.(2) of the Delta Air Lines, Inc., Process Standard 900-1-1 No. 18, dated February 1, 1996, requires a hot water rinse following the TURCO 4181 step.

Observation No. C7: This step was not performed during the cleaning process.

Recommendation: The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta *Air* Lines, Inc., is in compliance with this Process Standard.

The Delta Air Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996, requires **degreasing** all parts immediately prior to the FPI process.

Observation *No.* C8: TURCO 4181 is utilized after the degreasing operation, and is not included in the Delta *Air* Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996.

Recommendation: The Team recommends that Delta Air Lines, Inc., clarify the appropriate step for the utilization of the TURCO 4181 material in the processing of critical engine components. The Team also recommends that Delta Air Lines, Inc., bring both the Delta Air Lines, Inc., Process Standard 900-1-1 No. 18, dated February 1, 1996, and The Delta Air Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996, into compatibility with each other. The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., achieve compatibility between these two Process Standards.

The Delta Air Lines, Inc., Process Standard 900-6-3 No. *02,* dated June 15, 1996, states that it *is* absolutely necessary that **parts** to be FPI inspected be free from all surface contamination.

The Delta Air Lines, Inc., cleaning operation assumes that the Nondestructive Inspection organization can/will screen material coming in for suitability for FPI processing. The Nondestructive Inspection organization can only determine if the parts are too dirty for inspection, not if they have been cleaned adequately to allow FPI processing. Estimates from the Nondestructive Inspection organization ranged from 5-15 percent for material returned to the cleaning operation because it was too dirty for FPI processing.

Observation No. C9: There is no assurance that the material received by the Nondestructive Inspection organization for FPI processing was clean enough for an adequate FPI.

Recommendation: The Team recommends that Delta Air Lines, Inc., Nondestructive Inspection organization reevaluate the suitability of the cleaning processes performed prior to FPI. The Team also recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., accomplishes this recommendation and verifies the acceptability of the cleaning process.

C. Fluorescent Penetrant Inspection (FPI) Process

Observation No. F1: The Team noted that the Delta Air Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996, allows questionable indications to be evaluated by wiping the area once with solvent (Acetone was being utilized on the production line) using a cotton swab or h e - hair art brush and redeveloping the indication. The brush utilized on the production floor is a small stiff bristle parts cleaning brush.

Recommendation: The Team recommends that a brush be utilized in accordance with the Delta Air Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996. The Team recommends that the Delta Certificate Management Office, Atlanta, verify that Delta Air Lines, Inc., is in compliance with the Process Standard.

Observation No. F2: The solvent on the production floor the morning of August 14 was badly contaminated with fluorescing material.

Recommendation: The Team recommends that contaminated solvent be removed as soon as possible from the production area and be replaced with clean solvent. The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., is in compliance with this recommendation.

Observation F3: The Delta Air Lines, Inc., inspector working the production line on the afternoon of August 13 was using the solvent as a cleaning aid to remove excess fluorescing material, repeatedly flooding the inspection area with brushfuls of solvent in order to remove the flourescing material.

Recommendation: The Team recommends a more complete removal of excess penetrant material during processing, and retraining of personnel in the proper procedures for the evaluation of indications. The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., is in compliance with this recommendation.

Observation No. F4: Delta Air Lines, Inc., has initiated the generation of FPI Technique Sheets. Delta Air Lines, Inc., furnished a version of a Technique Sheet to the Team.

Recommendation: The Team recommends that Delta Air Lines, Inc., continue the generation of the Technique Sheets. The information included on the Technique Sheet included identification of the part, the method, the equipment, the inspection steps, aids and critical areas, along with a sketch of the component and an identification of critical inspection areas. The Technique Sheets are dated, reviewed and revisable. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of the Delta Air Lines, Inc., Technique Sheets.

Observation No. F5: Visible trash and debris were visible under the transport rollers utilized on the FF'I line. Since there are no protective covers over the tanks containing the FPI process materials, similar trash and debris is expected in the FPI material.

Recommendation: The Team recommends that Delta Air Lines, Inc., consider improved housekeeping, covers for the tanks or other application methods of the FPI material that would eliminate the utilization of tanks for dip application of FPI material. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of any changes made.

Observation No. F6: Delta Air Lines, Inc., has chosen in the Delta Air Lines, Inc., Process Standard 900-6-3 No. 02, dated June 15, 1996, Test Panels commonly referred to as TAM panels, as the quality assurance tool to be utilized on a daily basis to verify the effectiveness of

the FPI process. Each Penetrant sensitivity must display a minimum number of Star-Crack Indications on the TAM panel to ensure the sensitivity of the process. The panels are to be processed along with the first set of parts to be inspected per FPI line per shift. After processing, the panels should be cleaned to remove all inspection material and stored in alcohol. The TAM panels, when processed the afternoon of August 13, were so badly contaminated with background fluorescence that they were unreadable.

Recommendation: The Team recommends more attention by Delta Air Lines, Inc., to processing of parts to reduce indications of fluorescence contamination. The Team recommends that the Delta Certificate Management Office, Atlanta verify the acceptability of parts processing.

Observation No. F7: The TAM panels are not processed in the same way as parts are. At the development stage, a spray non-aqueous developer is used rather than the air delivered developer applied to the parts normally inspected.

Recommendation: The Team recommends that TAM panels see the same processing as the parts per the Process Standards for FPI , including the application of developer. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the compliance by Delta Air Lines, Inc., of this recommendation.

Observation No. F8: The panels are not checked for contamination/cleanliness before being used as quality standards.

Recommendation: The Team recommends the application of non-aqueous developer and viewing under a Blacklight to detect contamination of the TAM panels before each utilization of the TAM panels as a verification tool for the FPI process. The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that Delta Air Lines, Inc., is in compliance with this recommendation.

Observation No. F9: Two TAM panels from the production line and one used as a training aid were evaluated for contamination the morning of August 14. All were found to be contaminated with both fluorescent material and a light blue material which possibly was oil, emulsifier, or other cleaning agent. Numerous attempts were made by Delta Air Lines, Inc., personnel to clean the TAM panels. Simple wipes with solvent were unsuccessful at removing the contamination. Only the training aid panel was satisfactorily cleaned completely. The training aid panel was successfully processed and viewed with the comment from the inspector that they were the brightest and sharpest indications that he had seen.

Recommendation: The Team recommends that contamination ofthe panels be minimized, and that adequate cleaning of the TAM panels be conducted as necessary by Delta Air Lines, Inc. The Team recommends that the Delta Certificate Management Office, Atlanta, verify compliance with this recommendation

Observation No. F10: On March 4, 1996, Pratt & Whitney indicated their intention to replace all FF'I processes performed under Service Process Operation Procedures 82 (high sensitivity FPI processing) with Service Process Operations Procedures 84 (ultra high sensitivity FPI processing). Delta Air Lines, Inc., has the necessary equipment and materials in place, but has not fully implemented the change. There was some confusion on the part of a Delta Air Lines, Inc., Processor identifying the ultrahigh sensitivity penetrant material as a Delta 2, and the high sensitivity material as a Delta 1.

Recommendation: The Team recommends that the Delta Certificate Management Office, Atlanta, ensure that this transition from the high sensitivity FF'I to the ultra high sensitivity FPI is complete in the areas of documentation and training (including recurrent).

Observation No. F11: Developer is applied during the FPI process at Delta Air Lines, Inc., via an air stream under a hood.

Recommendation: For areas which contain long narrow holes, such as tie bolt holes, the Team recommends that Delta Air Lines, Inc., review the developer application process to ensure that the developer is adequately applied to areas that may be difficult to access. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of the developer application process.

Observation No. F12: The transport rings utilized for parts holding during the FF'I process become easily contaminated with fluorescent material. One inspector was noted having a difficult time inspecting the inside of a hole because of the high fluorescent background from the transport ring visible through the hole. He tried shielding the ring from view with his glove, but it also was contaminated with fluorescent material.

Recommendation: The Team recommends that Delta *Air* Lines, Inc., review techniques for viewing of inside of holes, improve if necessary, and adequately share with FF'I process inspectors. The Team recommends that the Delta Certificate Management Office, Atlanta, verify that Delta Air Lines, Inc., is in compliance with this recommendation.

Observation No. F13: One inspector was noted touching the component to be inspected, and smearing the inspection area, before inspecting it.

Recommendation: The Team recommends that recurrent training at Delta Air Lines, Inc., address this issue. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of the recurrent training.

Observation No. F14: There appears to be no uniform way of handling and indexing components during evaluation in the inspection booth.

Recommendation: The Team recommends that a uniform and consistent handling procedure, be established for components in the inspection booth. The Team recommends that the Delta Certificate Management Office, Atlanta, verify the acceptability of component part handling,

D. Other Observations and Recommendations

Observation No. 01: National Aviation Safety Inspection Program (NASIP) inspections were performed at Delta *Air* Lines, Inc., in 1991, 1994, and 1995. A significant number of findings related to Nondestructive Inspection were generated during 1991 and 1994. NASIP records from the Delta Certificate Management Office, Atlanta, indicate that the findings from 1994 related to Nondestructive Inspection that impacted the effectiveness of the FPI process are now closed. The disposition records from 1991 NASIP were not available from the Delta Certificate Management Office, Atlanta. The 1995 NASIP did not address inspection issues.

Recommendation: The Team recommends that the Delta Certificate Management Office, Atlanta, or Flight Standards Division initiate a focused NASIP type of review of Nondestructive Inspection related issues at Delta Air Lines, Inc. The review should include handling and cleaning issues which impact Nondestructive Inspection.

Observation No. 02: Delta Air Lines, Inc., management indicated that the Delta Continuous Analysis and Surveillance System (CASS) and Reliability Program had generated actions as a result of the Pensacola, Florida incident. However, the Team could not verify that any internal Delta Air Lines, Inc., audits, of either the engine cleaning department or the Nondestructive Inspection shop, had been performed subsequent to the incident in Pensacola, Florida.

Recommendation: The Teams technical review was limited in both time and scope, and did not verify the effectiveness of the CASS and Reliability Program. The Team recommends that Delta *Air* Lines, Inc., and the Delta Certificate Management Office, Atlanta, verify what actions the CASS and Reliability Program initiated at Delta Air Lines, Inc., after the Pensacola, Florida incident.

V. IN-BRIEFINGS AND OUT-BRIEFINGS

In-Briefing

AUGUST 13.1996

The FPI Technical Review Team conducted two In-Briefings. The first In-Briefing was conducted at the Delta Certificate Management Office, Atlanta. In attendance were the following:

A. Broz	- Team Leader, FPI Technical Review Team
R. Ganley	- Team Member
J. Harrington	- TeamMember
P. Harkins	- TeamMember
E. Hewitt	- Aviation Safety Inspector, Delta Certificate Management Office

The second In-Briefing was conducted at Delta Air Lines, Inc., Atlanta, Georgia, Maintenance Facility. In attendance were the following:

FPI Technical Review Team	- FAA
Mike Denaro	- Delta Air Lines, Inc., FAA/NTSB Liaison
David Doyal	- Delta, Manager, Quality Assurance Engineering Maintenance
Lee Clements	- Delta, Quality Assurance Foreman Nondestructive Inspection
Raymond Worley	- Delta, Quality Assurance Forman Nondestructive Inspection
Jim Mauceu	- Delta, Director, Compliance & Quality Assurance

Out-Briefing

AUGUST 14.1996

The FPI Technical Review Team conducted two Out-Briefings. The first Out-Briefing was conducted at the Delta Air Lines, Inc. In attendance were the following:

A. Broz	-	Team Leader, FPI Technical Review Team
R. Ganley	-	Team Member
J. Harrington	-	Team Member
P. Harkins	-	Team Member
Mike Denaro	-	Delta Air Lines, Inc., FAA/NTSB Liaison
David Doyal	-	Delta, Manager, Quality Assurance Engineering Maintenance
Lee Clements	-	Delta, Quality Assurance Foreman Nondestructive Inspection
Raymond Worley	-	Delta, Quality Assurance Forman Nondestructive Inspection
Jim Mauceu	-	Delta, Director, Compliance & Quality Assurance
Steve Predmore	-	Delta Manager, Human Factors, Dept. 025
Paul Vislosky	-	Delta Flight Safety
Ralph Hicks	-	Delta Flight Safety
Walt Baxter	-	Delta Engineer Maintenance
Bobby Jacobs	-	Delta, Powerplant Processor Cleaning Department
John Lauber	-	Delta, Vice President Corporation Safety & Compliance

The second Out-Briefkg was conducted at the Delta Certificate Management Office, Atlanta, on August 14, 1996. In attendance were the following:

FPI Technical Review Team	-	FAA
Lane Chandler	-	Manager, Certificate Management Office, Atlanta
Luvern Dokter	-	Delta Principal Maintenance Inspector
Jim Adams	-	Program Manager MD-80
Ed Hewitt	-	Program Manager Boeing 727

VI. DELTA AIR LINES, INC., COMMENTS

(Note. The following pages (25-42) represent Delta *Air* Lines, Inc., Comments)

In order for the **FAA** to issue this report in a timely manner, the FAA furnished Delta Air Lines, Inc., a courtesy copy of an earlier version, therefore allowing Delta **Air** Lines, Inc., the opportunity to comment. *Also* included in Delta **Air** Lines, Inc., Comments, are the essential contents of the Team's observations and recommendations as it appeared from the earlier version **to** Delta Air Lines, Inc.

TECHNICAL REVIEW OF FLUORESCENT PENETRANT
INSPECTION PROCESS - DELTA AIR LINES, INC.
AUGUST 13 & 14,1996

A. QUALIFICATION OF PERSONNEL

Section 13.A of Delta Air Lines Nondestructive Inspection Testing Procedure NDI-1, Revision 10, dated May 1, 1996 - Requires "All levels of personnel shall attend annual recurrent training in each method of certification no later than 30 days after the anniversary date of the previous recurrent or initial training".

OBSERVATION NO. 01:
A review of records in Department No. 542, indicates that recurrent trainings were performed beyond the 30 day grace period.

Recommendation: The Team recommends that the FAA Delta Certificate Management Office, assure Delta Air Lines, Inc., compliance with the Nondestructive Inspection Training Procedure NDT-1, Revision 10, dated May 1, 1996.

RESPONSE:
At the time of the inspection all NDI personnel training records were current and in compliance with Delta's Nondestructive Inspection Testing Procedure Manual. The records referred to were from 1994. At that time we were transitioning from paper records to the automated Professional Education and Recurrent Learning System, (PEARL). Delta identified the discrepancy with the PEARL record and immediately took corrective action,

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Section 14.A of Delta Air Lines Nondestructive Inspection Procedure NDT-1, Revision 10, dated May 1, 1996 - Requires "An individual remains qualified by performing work, providing instructions to trainees, and demonstrating proficiency in a method. Failure to do so within six months shall require the individual to be re-qualified by recurrent training."

OBSERVATION NO. 02:
Delta Air Lines, Inc., does not have any "formal" procedure to administer this requirement. The Team noted that it was up to each individual's Foreman to notify the Engine Maintenance Quality Assurance Manager of inactivity.

Recommendation: The Team recommends that a "formal" procedure be instituted to ensure that the individuals exceeding six months of inactivity do not perform inspections until they have been re-qualified.

RESPONSE:
All personnel at the time of this inspection were fully qualified in accordance with Section 14.A of Delta's Nondestructive Inspection Testing Procedure Manual. Delta agrees with the intent of the recommendation and will amend our policy as follows: All individuals who become inactive because of short term disability, leave of absence, or temporary transfer of responsibility will be decertified in the PEARL system. A monthly NDT Inspection Activity Report has been developed to assure compliance with the 6 month current requirement.

Section: 15.A of Delta Air Lines Nondestructive Inspection Procedure NDT-1, Revision 10, dated May 1, 1996 - Requires "ALL LEVELS OF PERSONNEL SHALL BE RE-CERTIFIED AT LEAST EVERY THREE YEARS. THIS RE-CERTIFICATION SHALL BE BASED UPON (a) evidence of continuing satisfactory performance; or (b) re-qualification by examination

OBSERVATION NO. 03:
The Team noted that re-qualification is based primarily on continuing satisfactory performance in lieu of an examination.

Recommendation: The Team recommends that the procedure be revised to require requalification of an individual by taking a written and a proficiency examination.

RESPONSE:
Delta was fully in compliance with its Nondestructive Inspection Procedure Manual, Section 15.A, which meets industry standards as specified in Specification 105. However, the recommended procedural change is an improvement to existing policy and will be implemented by Delta. Written and proficiency exams will become a part of the re-

qualification process. Delta reauests that this standard be communicated bv the team to the industry for revision to Soecification 105.

Delta Air Lines, Inc., Operations Policies and Procedures Document 00-10-25, dated June 12, 1996 - Defines duties of a Powerplant Processor. Currently Delta Air Lines utilizes Processors for the FPI process.

OBSERVATION NO. Q4:
During the Team's review, it was noted that there is no "formal" procedure to document the qualification of Processors. The Team also noted that unlike the Inspector, the Processor does not have "formal" on the Job Training (OJT).

Recommendation: The FPI is highly process dependent, and therefore, the Team recommends that Delta Air Lines reconsider the use of Processors for the FPI. The Team also recommends that Delta Air Lines establish a "formal" procedure to ensure that Processors are qualified to perform their review in FPI. The Team recommends that one way this may be accomplished is to manage Processor qualifications in a way similar to that used for Inspectors.

RESPONSE:
The Processors were trained and fully capable of performing their tasks as assigned. However, Delta agrees with the intent of the team recommendation and will develop "formal" procedures for Processor qualifications. This will consist of formal training, On The Job Training (OJT), and a qualification test. Processors will be certified and be given recurrent training. All training will be documented in PEARL. The Nondestructive Inspection Procedure Manual will be revised accordingly. Current processors will be certified by October 1,1996.

OBSERVATION NO. 05:
Delta Air Lines cleaning personnel receive OJT, with no formal classroom training. On the Job Training is provided on-each special cleaning operation and is logged in records established within the engine cleaning department. The Team noted that sensitivity to the criticality of the engine components and the end purpose for which these components were being cleaned after being

inducted into the cleaning shop was not provided as part of the OJT (critical rotating vs. static, general visual inspection vs. Nondestructive Inspection).

Recommendation: Delta Air Lines engine cleaning management personnel should incorporate special emphasis in the OJT program, pertaining to the differences in types of material and the critical nature of cleaning components which will later be released from the cleaning shop for FPI.

RESPONSE:
The handling of parts, critical or otherwise is covered under Delta's Job Planning Card. (JPC). The JPC is a routing document which identifies processes and steps in the restoration process. Our processors and inspectors process all parts in accordance with the paperwork provided. We have begun a training program in the cleaning shops to familiarize all personnel who have "stamp" authority (primarily inspectors and processors in the shops) with the different cleaning procedures. We will train all cleaning shop personnel under the same program and will incorporate special emphasis on the different materials and the cleaning of critical parts, especially those which will be subsequently fluorescent penetrant inspected.

B. CLEANING

On August 13-14, 1996, a review of Delta Air Lines, Inc. Powerplant Engine Cleaning Department was conducted as part of the Team review. The Delta Air Lines Engine Cleaning Department is considered by the Team as an integral part of the PI process.

OBSERVATION NO. C1:
There were noted discrepancies between audits performed by TURCOm the provider of cleaning chemicals, and Delta Air Lines, Inc., concerning cleaning tank solution contents. The corrective actions taken to bring the cleaning solution tanks within specification, by adding chemicals, were significant. No attempt was made by the Team to verify which was the correct audit.

Recommendation: The Team recommends that Delta Air Lines, Inc., establish weekly comparison inspectionsfaudits within the engine cleaning department to review both TURCO and Delta Air Lines, Inc., audit reports of cleaning tank chemical composition. When disparities between reports are noted they should be rectified before further processing.

RESPONSE:
Cleaning tank solutions are checked weekly by Delta's Maintenance Lab with the results of the checks provided within **a** few hours. In addition, Turco periodically checks tank solutions and their results are reviewed by the cleaning shop foreman. When there is a discrepancy between test results, appropriate action is taken immediately **to** ensure that the proper concentration of solution is present in the tank. It is not uncommon that significant adjustments will be made based on the number of parts run in any given period.

OBSERVATION **NO. C2:**
Interviews with Delta ***Air*** Lines, Inc., management and shop personnel indicate that Delta Air Lines has written procedures for cleaning processes for engine components. These written processes are developed by Delta Air Lines Process Engineering, either from the Original Equipment Manufacturer (OEM) Instructions for Continued Airworthiness, Chemical Product Distributors or Delta Air Lines Process Engineering. A full comparison of OEM data to Delta Air Lines Interpretative instructions was not conducted as part of this review. Delta Air Lines, Inc., process instructions for the cleaning **of** engine components are dictated by the Shop source **of** the component being inducted for cleaning on Job Planning Cards (JPC's). The components inducted into the engine cleaning shop ***are*** accompanied by this Delta Air Lines JPC which lists the cleaning process to be applied to the component. Specific cleaning process steps for those JPC's are contained in a manual, which is generally located in the cleaning shop Foreman's office and are available to shop personnel.

Specific process steps to clean engine components are not located at the cleaning worksites for cleaning personnel to review before commencing cleaning operations. Cleaning operations appear to be committed to memory for the components being cleaned, which could lead to errors in the cleaning process due to human factors

Recommendation: The Team recommends establishing engine cleaning instructions, or job aid instructions, such as material types, chemical solutions to be used, temperatures and dwell times. These process instructions should also accompany the component through the cleaning process and be readily available at the work sites so that operators will not have to rely on memory recall for cleaning processes.

(Response Below)

OBSERVATION NO. C3:
The Team observed that changes to cleaning processes when necessary are developed by Delta Air Lines, Inc., Process Engineering and routed to the cleaning shop for inclusion into this manual. The cleaning personnel are advised of these changes to the cleaning processes by the shop foreman or lead cleaners. It is not clear that should cleaning process operations change, with the absence of the foreman or lead cleaner, those changes would be distributed to cleaning personnel.

Recommendation: The Team recommends that a more formal process be established so that all cleaning personnel are consistently aware of changes made in the cleaning processes.

(Response Below)

OBSERVATION NO. C4:
There is no apparent procedures to verify with Delta Air Lines, Inc., Process Engineering that cleaning process changes have been implemented in the shop department.

Recommendation: The Team recommends that a consistent method be established to ensure that cleaning process changes are properly implemented and documented with Delta Air Lines, Inc., Process Engineering

(Response Below)

RESPONSE TO NO. C2/C3/C4:
Copies of the applicable Process Standards have been made and covered with mylar film. These copies have been put in notebooks that are placed at the beginning of the "cold line", the "hot line, in the blast area and adjacent to the ultrasonic cleaners and varsol booths. The cleaning shop foreman (or his designee in his absence) has the responsibility of

maintaining current information in these notebooks. When the Process Standards Manual is revised, the Technical Procedures personnel who actually replaces the superseded pages in the manual gives a copy of the highlight sheet to the cleaning shop foreman (or his designee, in his absence). The foreman reviews the revisions to the highlight sheets to determine if any of the cleaning procedures have been changed. If so, he runs copies of the latest pages and places them in the aforementioned notebooks in lieu of the superseded procedures. The foreman then puts a "read and sign" sheet in front of the notebook and insures that all personnel read the revised pages and sign the sheet to indicate that they have read and understand the changes. These "read and sign" sheets will be retained in the cleaning shop Foreman's office.

Section 4.C(1)(a)(1) of Delta Air Lines Process Standard 900-1-1 No. 18 - Requires that "Maintain tank solution at normal operating level with TURCO 5948R...at 145° to 155°F"

OBSERVATION NO. C5:
The Team noted that tank solutions are checked weekly to ensure that proper temperatures are maintained. This check is recorded on a log sheet which records the temperatures-for the TURCO 5948R and TURCO 4181 tanks. The acceptable temperature range noted on this log sheet (tank #1 cold line (CL)) is 140°F to 180°F, which is not in accordance with the temperature range identified in the noted Process Standard. A review of this log sheet indicates that the solution temperature has been out of limits for approximately a month. In addition, the TURCO 4181 solution temperature (tank #3 CL) has been out of limits for approximately a month also.

Recommendation: The Team recommends that tank temperatures be maintained in accordance with the noted Process Standards, and that the FAA Delta Certificate Maintenance Office, Atlanta, assures Delta Air Lines, Inc., compliance with this standard. Additionally, the Team recommends that Delta Air Lines, Inc., ensure that cleaning equipment temperatures are in range as indicated on temperature meters at the cleaning tanks, prior to processing components on a daily basis.

Response:
We agree with the recommendation to install temperature sensing gages and have initiated the process to have them installed. We are now checking the solution temperatures twice each day and adjustments are made to any tank out of limits. The Equipment

Maintenance department is replacing valves that cannot maintain the proper solution temperature.

Section 4.D.(1)(c) of the Delta Air Lines Process Standard **900-1-1** No. **18** requires a hot water rinse following the TURCO 5948R step.

OBSERVATION NO. C6 :
This step was not performed during the cleaning process

Recommendation: The Team recommends that FAA Delta Certificate Maintenance Office, Atlanta, assures compliance with this Process Standards.

(Response Below)

Section 4F.(2) of the Delta ***Air*** Lines Process Standard 900-1-1No. 18 requires a hot water rinse following the **TURCO 4181** step.

OBSERVATION NO. ***C7:***
This step was not performed during the cleaning process

Recommendation: The Team recommends that the FAA Delta Certificate Maintenance Office, Atlanta, assures Delta Air Lines, Inc., compliance with this Process Standards.

(Response Below)

RESPONSE TO C6/ C7:
At the Team's request, a raw piece of stock, not an actual titanium hub, was used for demonstration purposes only. However, our review of the Process Standard relating to these methods identified inconsistencies between the process flow chart and the written instructions. The written process for the titanium hub requires placing the hub in a vat containing TURCO **5948R** for approximately **30** minutes. The hub is then rinsed in cold tap water, followed **by** a hot water rinse. The hub is then placed into a vat with TURCO

4181 and cold water rinsed. The final rinse is with hot water for flash drying, (hot flash rinse). We have requested our process engineering department to review the need for a hot water rinse when parts are **to** be immediately dipped in a second degreaser, such **as TURCO 4181.** Any change in the cleaning process policy will be reviewed with the appropriate manufacturers prior to implementation. Additionally, all cleaning shop personnel will **be** alerted to and trained on any changes in procedure **(See** Responses Q5 and **C2/C3/C4).**

The Delta Air Lines, Inc. Process Standard 900-6-3 No. 02, dated June 15, 1996 • The Process Standard requires degreasing all parts immediately prior to the FPI process.

OBSERVATION NO. C8:
TURCO 4181 is utilized after the degreasing operation, and is not included in the Process Standards for FPI process.

Recommendation: The Team recommends that Delta ***Air*** Lines, Inc., clarify the appropriate step for the utilization of the **TURCO** 4181 material in the processing of critical engine components. The Team also recommends that Delta Air Lines bring both the Delta Air Lines Process Standard 900-1-1 No. 18, and the PS FPI into compliance with each other.

RESPONSE:
The **FPI** Process Standard will be revised to include degreaser **TURCO 4181.**

Delta **Air** Lines, Inc., Process Standards for FPI processing correctly states that it is absolutely necessary that parts to be FPI inspected be free **from** all surface contamination.
The Delta Air Lines, Inc., cleaning operation assumes that the nondestructive inspection organization can/will screen material coming in for suitability for FPI processing. The NDI organization can **only** determine if the parts are too dirty for inspection, not if they have been cleaned adequately to allow FPI processing. Estimates from the nondestructive inspection organization ranged from 5-15 percent for material returned to the cleaning operation because it was too dirty for FPI processing.

OBSERVATION NO. C9:
There is no assurance that the material received by the Nondestructive Inspection organization for FPI processing was clean enough for an adequate FPI.

Recommendation: The Team recommends that the Delta Air Lines, Inc., nondestructive organization reevaluate the suitability of the cleaning processes performed prior to FPI. The Team also recommends that the FAA Delta Certificate Management Office, Atlanta, assures Delta Air Lines, Inc., compliance with the Process Standards.

RESPONSE:
There is no universal standard for assessing the cleanliness of parts. Delta views the rejection of parts because of inadequate cleaning as a positive indication in the quality process. Delta works with the engine manufacturers to develop generic cleaning processes that will be acceptable for all engine types. However, there may be times when the initial cleaning process does not adequately meet the standard for a specific part, and additional cleaning is requested prior to processing for FPI. Inspectors have been assigned to the cleaning shop while cleaning processes and procedures are under review. The Pratt & Whitney Overhaul Standard Practices Manual 70-33-00 Page 1 gives guidance on checking parts for adequate cleanliness. The guidance is used by Delta Inspection prior to the FPI process. Delta is reviewing with our engine manufacturers the different criteria suggested by each. A process will be developed as the Delta standard and be included in Delta's Process Standards Manual.

C. FLUORESCENT PENETRANT INSPECTION (FPI) PROCESS

OBSERVATION NO. F1:
The Team noted that the Process Standards for FPI allows questionable indications to be evaluated by Wiping the area once With solvent (Acetone was being utilized on the production line) using a cotton swab or fine-hair art brush and redeveloping the indication. The brush utilized on the production floor is a small stiff bristle parts cleaning brush.

Recommendation: The Team recommends that a brush be utilized in accordance with the PS FPI.

(Response Below)

OBSERVATION NO. F2:
The solvent on the production floor the morning of August 14 was badly contaminated with fluorescing materiai.

Recommendation: The Team recommends that contaminated solvent be removed as soon as possible from the production area and be replaced with clean solvent.

(Response Below)

RESPONSE TO NO. F1/F2
The brushes Delta has always used in the FPI tents are fine-haired brushes. The following actions were taken to prevent contamination of solutions: 1. Acetone is replaced daily. 2. Cotton swabs or fine-hair brushes are discarded after each use. 3. If a swab or brush is inadvertently dipped, the acetone is discarded and replaced in a cleaned container. 4. There is a daily log for each FPI tent to show compliance with this policy.

OBSERVATION NO. F3:
The Delta Air Lines, Inc., inspector working the production line on the afternoon of August 13 was using the solvent as a cleaning aid to remove excess fluorescing material, repeatedly flooding the inspection area with brushfuls of solvent in order to remove the indication.

Recommendation: The Team recommends that more careful removal of excess penetrant material during processing and retaining of personnel in proper procedures for the evaluation of indications.

RESPONSE:
The steps being taken to standardize inspection techniques, i.e., technique sheets, training classes, and On the Job Training (OJT) will prevent reoccurrence of the observed practice.

OBSERVATION NO. F4:
Delta Air Lines, Inc., has initiated the generation of FPI Technique Sheets. Delta Air Lines, Inc., furnished a version of a Technique Sheet to the Team.

Recommendation: The Team recommends that Delta Air Lines, Inc., continue the generation of the technique sheets. The information included on the Technique Sheet included identification of the part, the method, the equipment, the inspection steps, aids and critical areas, along with a sketch of the component and an identification of critical inspection areas. The Technique Sheets are dated, reviewed and revisable.

RESPONSE:
The development of technique sheets is an ongoing process for NDI methods.

OBSERVATION NO. F5:
Visible trash and debris were visible under the transport rollers utilized on the FPI lines. Since there are no protective covers over the tanks containing the FF'I process materials, similar trash and debris is expected in the FPI material.

Recommendation: The Team recommends that improved housekeeping, and that covers or other application methods of the FPI material that would eliminate the utilization of tanks for dip application of FPI material.

RESPONSE:
The transport roller areas have been cleaned and placed on a maintenance program. The present system for dip application of FPI material is old but adequate. Until the entire system can be replaced, there will be instances of material falling to the bottom of the tank The fluid is checked for water contamination monthly, brightness quarterly, and emulsifiers weekly, along with panels being run prior to the start of each shift.

OBSERVATION NO. F6:
Delta Air Lines, Inc., has chosen Process Standard 900-6-3 No. 02, Test Panels commonly referred to as TAM panels, as the quality assurance tool to be utilized on a daily basis to verify the effectiveness of the FPI process. Each Penetrant sensitivity must display a minimum number of Star-Crack Indications on the TAM panel to assure the sensitivity of the process. The panels are to be processed along with the first set of parts to be inspected per FPI line per shift. After processing, the panels should be cleaned to remove all inspection material and stored in alcohol. The TAM panels, when processed the afternoon of August 13, were so badly contaminated with background fluorescence that they were unreadable.

Recommendation: The Team recommends more attention to processing of parts to reduce indications of fluorescence contamination.

RESPONSE:
The cleaning of TAM panels was in accordance with our Process Standard. The handling and processing of panels has been reviewed and revised to the standard recommended by the team. Delta's Process Standard is being revised accordingly. All inspectors have been trained on the new procedure.

OBSERVATION NO. F7:
The TAM panels are not processed in the same way as parts are. At the development stage, a spray non-aqueous developer is used rather than the air delivered developer applied to the parts normally inspected.

Recommendation: The Team recommends that TAM panels see the same processing as the parts per the Process Standards for FPI, including the application of developer.

RESPONSE:
Delta does not spray non-aqueous developer on TAM panels, so the observation as written is confusing. The TAM panels are processed in the same way as parts, including the application of the dry powder developer.

OBSERVATION NO. F8:
The panels are not checked for contamination/cleanliness before being used as quality standards.

Recommendation: The Team recommends the application of non-aqueous developer and viewing under a Blacklight to detect contamination of the TAM panels before each utilization of TAM panels as a verification tool for the FPI process.

RESPONSE:
A new Process Standard procedure has been developed to process TAM panels. The standard recommended by the team has been incorporated. (Reference Response F6)

OBSERVATION NO. F9:
Two TAM panels from the production line and one used as a training aid were evaluated for contamination the morning of August 14. All were found to be contaminated with both fluorescent material and a light blue material which possibly was oil, emulsifier, or other cleaning agent. Numerous attempts were made by Delta Air Lines, Inc., personnel to clean the TAM panels. Simple wipes with solvent were unsuccessful at removing the contamination. Only the training aid panel was satisfactorily cleaned completely. The training aid panel was successfully processed and viewed with the comment from the inspector that they were the brightest and sharpest indications that he had seen.

Recommendation: The Team recommends that contamination of the panels be minimized and that adequate cleaning of the TAM panels be conducted as necessary.

RESPONSE:
Validation TAM panels were being cleaned in accordance with Process Standard 900-6-3 No.2, an industry standard. Considerable testing has been conducted since the team visit. A new procedure, using Non Aqueous Wet Developer (NAWD), has been developed and will be incorporated into Delta's Process Standard. It was noted during testing with newly acquired panels, which had not been run, that the solvent in NAWD creates a blue haze on the test panel when viewed under black light. This may explain some of the difficulties encountered during the panel tests conducted by the team.

OBSERVATION NO. F10:
On March 4, 1996, Pratt & Whitney indicated their intention to replace all FPI processes performed under Service Process Operation Procedures 82 (high sensitivity FPI processing) with Service Process Operations Procedures 84 (ultra high sensitivity FPI processing). Delta Air Lines has the necessary equipment and materials available and has practically implemented the change. There was some stumbling on the part of a Delta Air Lines Processor identifying the ultrahigh sensitivity penetrant material as a Delta 2, and the high sensitivity material as a Delta 1.

Recommendation: The Team recommends that the FAA's Delta Certificate Management Office, Atlanta, assure the transition is complete for the documentation and training (including recurrent) that must accompany the change.

RESPONSE:
The Job Planning Cards (JPC's) which accompany all parts identify the Type Penetrant and Class of material to be used for FPI parts. All tanks are clearly marked as to Class of material. Training classes have been conducted reinforcing procedures.

OBSERVATION NO. F11:
Developer is applied during the FPI process at Delta Air Lines via an air stream under a hood

Recommendation: For areas such as long narrow holes, such as tie bolt holes, the Team recommends reviewing the developer application process to assure that developer is adequately applied to areas that may be difficult to access.

RESPONSE:
It is recognized throughout the industry that there are limitations on the use of FPI for certain parts. Delta follows manufacturer specifications and accomplishes inspections in accordance with established guidelines. Developer application is being reviewed to assure coverage in areas that are difficult to access.

OBSERVATION NO. F12:
The transport rings utilized for parts holding during the FPI process become easily contaminated with fluorescent material. One inspector was noted having a difficult time inspecting the inside of a hole because of the high fluorescent background from the transport ring visible through the hole. He tried shielding the ring from view with his glove, but it also was Contaminated with fluorescent material.

Recommendation: The Team recommends Delta Air Lines, Inc., review techniques for viewing of inside of holes, improve ifnecessary, and adequately share with FF'I process inspectors.

RESPONSE:
The development of technique sheets will aid in the inspection process of viewing critical areas. Also, clean transport rings will be substituted prior to the **FPI** inspectionto minimize fluorescent background exposure.

OBSERVATION NO. F13:
One inspector was noted touching the component to be inspected, and smearing the inspection area, before inspecting it.

Recommendation: The Team recommends recurrent training at Delta Air Lines address this issue.

RESPONSE:
The recently developed technique sheet will minimize handling of parts. All **FPI** personnel have been trained on the new procedure. It should be noted that on the day the process was reviewed the part in question had been under inspection for approximately ten minutes before the Team member arrived. This was communicated to the team member.

OBSERVATION NO. F14
There appears to be no uniform way of handling and indexing components during evaluation in the inspection booth.

Recommendation: The Team recommends a uniform, consistent handling procedure be established for components in the inspection booth.

RESPONSE:
The recently developed technique sheet specifically states how a part is to be indexed and handled. All FPI personnel have been trained on the new procedure.

D. OTHER OBSERVATIONS

OBSERVATION NO. 01
National Aviation Safety Inspection Program (NASP) inspections were performed at Delta in 1991, 1994, and 1995. A significant number offindings related to nondestructive inspections were generated during 1991 and 1994. NASIP records from the FAA's Delta Certificate Management Office, Atlanta, indicate that the findings from 1994 related to Nondestructive Inspection that impacted the effectiveness of the FPI process are now closed. The disposition records from 1991 NASP were not available from the FAA's Delta Certificate Management Office, Atlanta. The 1995 NASIP did not address inspection issues.

Recommendation: The Team recommends that the FAA's Delta Certificate Management Office, Atlanta, or Flight Standards Division initiate a focused NASP type of review of nondestructive inspection related issues at Delta Air Lines, Inc.. the review should include handling and cleaning issues which impact Nondestructive Inspection.

RESPONSE:
There were eight findings in the 1994 NASIP that referenced FPI. None of the findings were significant and none of the findings highlighted problems with FPI processing. To make a comparison between this process investigation and a standard NASIP audit is misleading and inappropriate. All findings were closed to the satisfaction of the local FAA, and the FAA's Technical Standards Branch conducted a separate review for comprehensive corrective action for all findings.

OBSERVATION NO. **0 2**

Delta **Air** Lines, Inc., management indicated that Delta Continuous Analysis and Surveillance System (CASS) and Reliability Program had generated actions. However, the Team could not verify that any internal Delta **Air** Lines audits of either the engine cleaning department or the nondestructive inspection shop had been performed subsequent to the accident in Pensacola, Florida.

Recommendation: The Teams technical review was limited in both time and scope, and did not verify the effectiveness of the CASS System. The Team recommends that Delta Air Lines and the FAA's Delta Certificate Management Office, Atlanta, verify that the CASS and Reliability program initiated corrective actions that were instituted by Delta Air Lines after the hub failure.

RESPONSE:
Delta reacted to the accident of flight **1288** on July **6,1996,** at the highest level. Audits were immediately conducted by our Quality Assurance groups in the following areas and in close cooperation with the FAA and engine manufacture. These consisted of the **-219** engine build requirements, the **-219** titanium hub assembly and disassembly procedures and the JPC's for FPI processing. The local FAA Flight Standards office has been interacting with Delta throughout the entire process. All audit findings are clearly documented and available for review. Delta continues to work with our Flight Standards office to resolve all NTSB or FAA concerns and comments. We would have appreciated the opportunity to review the actions taken by Delta had time permitted.

MI. REFERENCES

The following documents serve as the basis for a number of comments made in this report. These documents are included here by reference and not in their entirety.

1. The NTSB Safety Recommendation Letter: (In reply refer to: A-96-74 through 77), dated July 29, 1996

2. Nondestructive Evaluation (NDE) Capabilities Data Book: Nondestructive Testing Information Analysis Center (NTIAC) Texas Research Institute Austin, Inc., NTIAC:DB-95-02, dated May 1996

3. Department of Transportation. Federal Aviation Administration. National Aviation Safety Inspection Program Report: Delta Air Lines, Inc., Atlanta, Georgia, dated March 21, 1991

4. Department of Transportation Federal Aviation Administration. Flight Standards Division National Aviation Safety Inspection Program Inspection Report: Delta Air Lines, Inc., Air Carrier Certificate Number: DALA026A, Atlanta, GA, dated July 29, 1994

5. Department of Transportation. Federal Aviation Administration Flight Standards Division. National Aviation Safety Inspection Program Inspection Report: Delta Air Lines, Inc., Air Carrier Number DALA026A, Atlanta Georgia, conducted November 27, 1995 through December 8, 1995

6. Fluorescent Penetrant Inspection Technique Sheet: DOC # PT0001, dated July 16, 1996

7. Magnaflux Z5 Test Panel Data Sheet. (also known as "TAMPanel"). Magnaflux is a Division of Illinois Tool Works Inc., Ill

8. Pratt & Whitney Overhaul Standard Practices Manual,] uor nt P I SPOP 84: Ultra - High S itivity Fl it P tra t Ins i dated May 15, 1996

9. Pratt & Whitney Overhaul Standard Practices Manual. Fluorescent Penetrant Inspection: SPOP 82: High Sensitivity Fluorescent Penetrant Inspection dated May 15, 1996

10. Pratt & Whitney Guidance: SPOP 82 to SPOP 84, Increased Sensitivity FPI. Pratt & Whitney, dated March 4, 1996

11. Delta Process Standard: Inspection - Fluorescent Penetrant, (900-6-3-No. 02), dated June 15, 1996

12. Delta Air Lines. Inc.. Process Standard, Paint Stripping, Dry Film Lubricant And Carbon Removal - Tank Method, (900-1-1 No. 18), dated February 1, 1996

13. Delta Air Lines. Inc.. Nondestructive Insuection Training Procedure, NDT-1, Revision 10, dated May 1, 1996

14. Delta Air Lines. Inc.. Operations Policies and Procedures, (00-10-25), dated June 12, 1996